

# THE ANNALS

AND

## MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 118. OCTOBER 1877.

---

XXXIII.—*On the Salenidæ, Wright.*—Part II. *Observations on the Morphology of Recent Saleniæ, and Description of a new Species.* By P. MARTIN DUNCAN, F.R.S., Pres. Geol. Soc.

[Plate VII.]

IN the first part of this essay \* I noticed the spheridia and pedicellariæ of a specimen of a recent *Salenia* which I considered to be probably referable to the species described by A. Agassiz, and named by him *Salenia varispina*; and now I proceed to the comparison of the other structures of the test in the recent forms. But before doing so it is necessary to consider the zoological position of the specimens.

The specimen just noticed, and which has its spines and buccal membrane intact, was covered here and there with deep-sea ooze, in which were many *Globigerinæ*. This sticky substance enveloped the pedicellariæ, filled up the spaces between the papillæ on the apical disk, and only permitted a general view of the abactinal system. Long and careful manipulation at intervals has got rid of sufficient ooze, so that the correct structural relation between this form and that described and figured by A. Agassiz can now be decided. I now find that, although there are some differences in the nature of the buccal membrane and in the numbers of the primary tubercles of the two forms which may be accounted for by their being

\* Ann. & Mag. Nat. Hist., July 1877.

of different ages, there is a marked distinction between their apical systems which has nothing to do with age and which transcends any variation. The new form is a true *Salenia* in respect of the position of the extra or subanal plate and of the anal opening; but the form described and figured by A. Agassiz has, as he has noticed, the characters of *Hyposalenia* (that is to say, of *Peltastes*), and it presents in the figure altogether abnormal characters as one of the Salenidæ\*. The *Salenia Goesiana*, Lovén, small as the only specimen is, still has all the generic characters of the true *Salenie*, and thus is more closely allied to the new form than to *Salenia varispina*. The questions arise, then, Are the new form and *Salenia varispina* varieties of a type, or are there three recent species of Salenidæ? In endeavouring to reply, the value of the generic attribute of *Peltastes* interferes to a certain extent, and it must be admitted that the figures given by A. Agassiz indicate as great a difference between his and the other forms of recent Salenidæ as there is between some of the fossil species of *Salenia* and of *Peltastes*. If it can be admitted that it is within the variability of a species of *Salenia* for the anus to assume the position usually supposed to be characteristic of the genus *Peltastes*, there is no necessity for the alteration in generic title of *S. varispina*; but as yet there is no right to assume it. Under the circumstances, indisposed as we ought to be to alter the generic position of a previously described species and to found a new species on one specimen alone, it appears nevertheless advisable to place the interesting form described by A. Agassiz in the genus *Peltastes*.

The recent Salenidæ may be therefore arranged as follows; and as this communication will deal with the Tertiary forms also, it is as well to introduce their names:—

#### SALENIDÆ.

<i>Peltastes varispina</i> , Agass. sp.	} Recent.
<i>Salenia Goesiana</i> , Lovén.	
<i>Salenia profundæ</i> , nobis.	
<i>Salenia tertiaria</i> , Tate †.	Australian Cainozoic.
<i>Salenia Pellati</i> , Cotteau †.	Biarritz Nummulitic.

The specific characters of the new species will be given

\* "The abactinal system has the structure of that of *Salenia*; but the position of the anal system is that of *Hyposalenia*." (A. Agassiz, 'Rev. Echini,' 1872, p. 261. Compare his plate iii. f. 8-14 with this statement.)

† Prof. R. Tate, F.G.S., Quart. Journ. Geol. Soc. vol. xxxiii. p. 258, 1877.

‡ M. G. Cotteau, Revue et Mag. de Zool., Mai 1860, p. 212 (Paris).

further on, and after the examination of the morphology of the other recent forms.

To resume the morphology of *Salenia profundæ*. The peristome is moderately large and wide, and it bears the ratio of 1.75 to 2.75 to the widest part of the test. It is circular in outline; and the cuts for the gills are small; moreover the edge of the test is slightly everted so as to form a faint marginal ridge. The remains of the gills are to be seen in the specimen; and they are bifid, appearances of a trifid arrangement being visible in some (fig. 10). The actinostome (the opening for the teeth), circular in outline, is at the end of a conical projection of the buccal membrane; its edge is plain, and there are faint indications of imbrication close to it, but not elsewhere on the membrane. This membrane has a rather large surface; it is plain, except close to the actinostome, and presents a remarkably glistening appearance interrupted by minute pigment dots; and this appearance is produced by its containing in its upper layers minute geometrical scales of carbonate of lime separated by less-silvery-looking tissue, and the whole speckled with dark purple pigment. This silvery plain surface reaches to the edge of the peristome, and it becomes continuous with the superficial ornamentation of the test, which, without having the separate microscopic plates, is white, glistening, and pigmented.

Moreover the membrane so covers the ten buccal plates that their place can only be suggested by the presence of the five pairs of buccal tentacles and their associated pedicellariæ: it is continued up onto the base of each tentacle, and it gives origin to the stalks of the pedicellariæ (fig. 9). The buccal tentacles in five pairs are situated at rather more than one third of the distance from the peristome to the actinostome; and one pair is opposite to each ambulacrum. Each tentacle has an elongate and elliptical sucker with fine radiating lines of slight depression at the edge, and a stout stem, which is marked with transverse circular constrictions and also by a few longitudinal striæ which are continuous with those of the edge of the sucker. Each pair of tentacles has two pedicellariæ close to them; and these are situated between and rather internal to them. The pedicellariæ are glistening and icy in appearance; the rather long peduncle is stoutish and is swollen slightly here and there; and at the free end is a rounded knob for the articulation of the cavity of the head. This is broad, tapering, short; and the jaw-slit is short and nearly free from any raggedness. The bifid nature of the pedicellariæ is seen in one instance where the head seized the sucker of the neighbouring tentacle in its death-grasp.

The ends of the teeth are closely applied to each other, and there is no space between their visible sides in the solitary specimen; they are bluntly and broadly keeled externally and have angular ends.

No mention is made by Lovén of the buccal membrane of *Salenia Goesiana*; but A. Agassiz writes as follows regarding that of *Peliastes varispina*:—"The imbricated buccal membrane is covered thickly with plates arranged somewhat as they are in *Echinocidaris*. The ten buccal plates placed half-way between test and teeth are sparingly covered with pedicellaræ" (*op. cit.* p. 261). In *Salenia profundi* the imbrication is of the faintest close to the actinostomial opening, and does not exist elsewhere, and no plates are visible; but as *Echinocidaris* = *Arbacia*, in which genus the buccal membrane is bare, it is probable that there is no great amount of imbrication in the interesting specimen described by A. Agassiz. The actinal cuts are small in the three recent Salenidæ.

Most of the spines being in place in the specimen of *Salenia profundi*, only a few tubercles can be examined; but they are invariably, whether in the interambulacra or in the ambulacra, imperforate. The large primary tubercles of the interambulacra have large bosses; and their crenulation resembles a circular series of nodules around their bases. This appearance, differing from the usual crenulation, is shown to exist in *Salenia Goesiana* by the help of Lovén's magnificent delineation (Lovén, 'Études,' pl. xix. fig. 164). It differs from that drawn by A. Agassiz.

No crenulation is found around the ambulacral tubercles in the two species of *Salenia*; but the following quotation from the 'Revision of the *Echini*' makes it doubtful whether it is not found in the varispine species:—"The primary tubercles of both areas are imperforate, but distinctly crenulated." A careful examination of the plate in illustration does not satisfy the eye that there is crenulation in the ambulacra.

The number of the tubercles in the interambulacra of *Salenia profundi* and *Salenia Goesiana* is not more than ten, counting all of both rows; but, although A. Agassiz does not give the number, it is evident from his drawings that there are more than ten in his species. It must be remarked that the size of the specimen described by A. Agassiz is larger than that of the other two forms, and that the increased number of tubercles may be a matter of growth. It is impossible, however, to restrict the number of coronal plates to a "few," or the number of principal tubercles to ten in the genus *Salenia* (see 'Revision of *Echini*,' p. 258); for in the Australian

Tertiary form there are as many as fifteen primary tubercles in an interambulacrum. But, on the other hand, it is evident that the number of primary tubercles is indicated long before the test assumes its largest size.

The recent Salenidæ now under examination have all two rows of small secondary tubercles in each median interradi- al space; and in this they differ remarkably from the Australian Tertiary *Salenia*, but resemble the Nummulitic species.

A row of small secondaries is placed just outside the poriferous zone in *Salenia profundæ*. The ambulacral tubercles of *Salenia profundæ* are very decidedly smaller than the largest of those of the interambulacra; they are small, numerous, in two vertical rows; and two or three near the peristome are slightly larger than the others. They are placed so that there is a free vertical space between the rows, in which are placed the vertical set of pedicellariæ. Omitting the remarks about the pedicellariæ and the larger tubercles, the same arrangement prevails in the other Salenidæ as yet known from the deep sea. The ambulacra are narrower than the interambulacra in all, and they slightly diminish in breadth at the peristome.

As the test of the specimen of *Salenia profundæ* is not denuded, it is impossible to estimate the number of the pores in the poriferous zone; but the presence of some tentacles close to the peristomial end of the ambulacra indicates that the pores are in simple series and comparatively few in number. In this the species conforms to the description of the varispine form by A. Agassiz, and also to that of *Salenia Goesiana*. There would appear to be a single pair of pores to each ambulacral plate; and, as far as I can determine, each plate has an ambulacral tubercle parallel with the pores. This is not what occurs in the Tertiary forms or in those of more ancient date; for in them there is a pair of pores in relation with each ambulacral tubercle, and also a pair intermediate and in relation with a space between the successive vertically arranged tubercles. The tentacles of *Salenia profundæ* are stout, not very long, and present a stem and disk. The stem is constricted here and there transversely; and the circular disk is occasionally ragged at the margin or is marked there by slight furrows. The base of the tentacle is often pigmented. Lovén states that in *Salenia Goesiana* the pores are in simple series and are surrounded by an oval "enceinte" with raised edges. This is not apparent in the other recent Salenidæ, but it is not without its analogue in some fossil forms.

A. Agassiz was struck with the varied nature of the spines of the form he described from the Florida Expedition; and

hence its appellation. He writes (*op. cit.* p. 261), "The primary spines are enormous, twice the diameter of the test in length, of a brilliant white colour and of all shapes. Some of them are uniformly tapering, others swelling at about one third the distance from the base, others flattened and curved, but all longitudinally striated and loosely covered with sharp spines irregularly arranged along the body of the spines. The secondary spines, as well as the greater number of the spines of the ambulacra, as far as the ambitus, are short club-shaped, sometimes curved and flattened, longitudinally striated, with slight serrations. These short spines give to the median interambulacral and ambulacral zones the aspect of the corresponding zones of *Cidaris*, but they are not, as in *Cidaris*, arranged in a circle around the base of the primary spines. These small spines, as well as the whole abactinal area, are covered with prominent dark violet pigment-cells, standing in striking contrast to the white primary spines." In the plate (pl. iii. figs. 8 and 14, *op. cit.*) A. Agassiz delineates this remarkable variety of spines. Lovén does not notice spines at all; and hence we may suppose that his specimen was denuded.

In the specimen of *Salenia profundæ* the spines are all preserved, and are of great interest, both on account of their variety and ornamentation.

The few largest primary tubercles situated above the ambitus and close to it bear very long spines, which are  $\frac{1}{10}$  inch long, or very nearly four times the length of the diameter of the test (fig. 11). These largest spines are slender, and taper off gradually towards the end, but are slightly swollen midway and towards the succeeding quarter of their length. Usually they are nearly straight, cylindrical, and pin-shaped. They are finely ridged longitudinally, there being ten or twelve low long ridges with corresponding grooves, and the ridges are very minutely aciculate or serrate. They are not flat or much bent; and the spinules on them are in regular whorls at stated intervals. The spinules are numerous in each whorl, and are bent, the point being outwards and nearly parallel with the spine. The whorls succeed a plainly striated region close to the base of the spine above the socket, and are closer together than further up. Then they become fewer and smaller, and finally disappear near the tip, where the delicate ridges or flutings become finer and are either excessively minutely serrate or the termination has a cellular appearance under a moderate magnifying-power. Pigment granules are seen on the lowest part only of the largest spines; but most of the fine ornamentation is covered with a fluffy adventitious matter.

Other long spines, shorter than the above, are more slender, and the whorls of spinules are not so numerous; but there is still a faint pigmentation on and just above the milled ring. A third set of spines are shorter and more slender than these last; and a fourth, noticed close to the peristome, in the ambulacra and just above the spheridia, are still smaller, slightly bent, with or without whorls of spinules, and with the pigmentation carried along further on the longitudinal ridges (fig. 6).

The next group of spines are very remarkable, and they are all short. Some are large at the milled ring, and stout and conical, looking like aborted great spines; they are marked with lines of pigment to the tip. Others are smaller and have serrate edges to the ridges and the same kind of ornamentation (fig. 5). In all these kinds of spines the milled ring is large and faintly crenulate.

Finally there are numerous flat club- or stout spatula-shaped short spines on the ambulacra and median interambulacra. These are situated on small tubercles, which are not crenulate; and the milled ring of each spine is a mere expansion: usually the shaft is constricted for a space and then expands gradually and rounds off close to the tip (fig. 4). Some are rod-shaped (but this is not common); and some are bent laterally; and in all, lines of pigment run longitudinally and conform to the outline, having a dotted appearance here and there. Some of these spines are found on the anal membrane, which covers the plates there (fig. 2); and they are evidently connected with minute tubercles. A vertical row of these spines, many being small and thin, covers the tubercles just outside the poriferous zone in the interambulacra. Finally, above the ambitus it will be noticed that in one or two places the club-shaped spines do assimilate in position to those of the Cidaridæ, and environ more or less the bases of the great tubercles. The vertical rows of these spines, both in the ambulacra and in the median space of the interambulacra, diverge at their tips, and present the appearance so well illustrated by A. Agassiz (fig. 4).

The comparison of these spines and those described by A. Agassiz with the fossil forms will be made in the next communication; but it is as well to remark that the resemblance is only in the variety of the spines in a slightly clubbed condition in the fossils and in some of them being bent.

The abactinal system of *Salenia profunda* differs materially from the form described by A. Agassiz, and less so from *Salenia Goesiana*. I agree with Lovén, Wright, and Cotteau, and have always taught, that the position of the madreporic

plate is forwards and to the right; and I am impressed with the truth of the observations and demonstrations of the great Scandinavian naturalist relating to the distribution of the pores and tubercles at the peristomial margin with reference to the antero-posterior axis of the test. A. Agassiz maintains the exactly opposite opinion, and places the madreporic plate posteriorly and to the left. As the question has been ably advocated by the above-mentioned authors, it is only necessary to refer to their works on the subject. But it is by no means easy to distinguish the madreporic plate from the others in most Salenidæ; yet a guide to its position may be found in the fact that the anus proper infringes upon two generative plates, which in the genus *Salenia* are posterior, or rather one is posterior and the other posterior and to the right; hence the madreporic plate will be found immediately anterior to this last-mentioned plate. If the test be so placed that the generative plates are in this position, an ocular plate (that to the left of the madreporic plate) will be directly anterior, and a line drawn through its middle and carried directly backwards will run along the suture between the madreporic plate and the left anterior generative plate, and will pass over the so-called sub- or suranal plate and reach the margin of the anus.

In the new species of *Salenia* the abactinal system, more or less pentagonal, covers nearly the whole of the abactinal surface: it is irregularly convex, and the highest point is not quite central, and is situate in a part of the raised margin of the eccentric anal orifice where it is in contact with the subanal plate (subanal meaning before the anus) (fig. 8). This convexity, accompanied as it is by an eccentric position of the anus, which, moreover, slopes backwards and to the right, renders any delineation of the apical disk, except as a diagram, very incomprehensible. The subanal plate is central, the anal opening infringing on its posterior and right part; and it slopes away from the raised margin of this opening. The posterior and the right posterior generative plates, which with the subanal plate contribute to the anal opening, are narrow, the orifice reaching not very far from their outer edges. To complicate the comprehension of the disk, the whole surface is studded with papillæ,—not embryonic spines; for they are not placed on tubercles, but are minute wart-like projections of the test, usually smallest at the base and rounded at the top, the whole surface being reticulate, mulberry-looking, and pigmented with dark-violet grains in the furrows (fig. 3). Some are thin, and some are longer than others; some, especially in the margin of the anus, are broad; and many are crowded in the



ocular plates. They are separated by slight spaces, in which are short pedicellariæ; and they hide the generative and ocular pores. As water soaks in easily when placed on the plates, there is no doubt that the pores are there; but the madreporic plate has no evidence of its peculiar body. The madreporic plate is slightly longer in the antero-posterior direction than the others; it has a group of close and rather tall, rounded processes of the test in the middle; and its free edge is slightly convex, and is rendered irregular by the outward projection of some similar growths. It is pentagonal, and the outer edge is shorter than that connected with the generative plate behind and the subanal plate. Next in size is the left anterior generative plate: it is irregularly covered with the peculiar processes; and pedicellariæ are between them. The generative plate behind this one is narrower and longer, and is covered with the same kind of ornamentation and pedicellariæ. The posterior plate of all is very narrow; for the anus infringes much upon it. The remaining generative plate is irregular in shape, generally narrow; and, like that last mentioned, is covered with the peculiar processes and pedicellariæ.

The two plates last mentioned are the smallest, and they contribute to the formation of the anal opening.

The subanal plate, in front and to the left of the anus, is irregularly geometrical in outline, is aslant, curved, and ornamented like the others. It is smaller than the madreporic plate.

There is no projection of the outer edges of the generative plates upon the test beyond the line of the ocular plates; and they are ragged from ornamentation.

The sutures are marked by distinct purple pigmentation; they are slight furrows; but no lateral slits or pores are noticed.

The ocular plates differ in size. The front one and the right in front are the largest; all are very irregular in their shape on account of the ridges and processes upon them (fig. 3). In some there is a prominent outer angle, and then the free edge is nearly straight and nodular, and the right posterior is very close to the anal margin. The smallest ocular plates are the posterior. The pedicellariæ are well seen in some.

The anus is large (fig. 2), nearly circular, and but slightly elliptical; it is eccentric in the right posterior direction; and its raised margin is nearly complete. It infringes on the subanal, the posterior, and the right posterior generative plates, and is behind and to the right of the centre of the apical system. The subanal plate, irregularly pentagonal, limits about one third of the anus; and the suture between the posterior plate and the

subanal crosses the raised margin, as does that between the subanal and posterior right generative plate. The margin thus incised is composed of processes from the subanal and the generative plates just mentioned, and is ragged from the presence on it of the peculiar broad processes already noticed. The anal membrane covers in the anus, except at a small spot rather to the right of and behind the centre; and there are at least two imperfect concentric rows of embryonic spines and ornamental processes on the membrane, the opening being in the midst; pedicellariæ exist there also (fig. 2).

With regard to the species described by A. Agassiz, that author may be thus quoted from the 'Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College—No. VII. Revision of *Echini*,' pts. i. and ii. p. 262:—"The abactinal system covers nearly the whole of the abactinal part of the test; the anal system is eccentric. There is a marked difference in the size of the genital plates, the three posterior ones being much larger than the two anterior ones; the reverse is the case with the ocular plates. In the largest genital plate there is a trace of the madreporic body, corresponding to the position of the axis assigned to it by Forbes, Müller, and Wright, which cuts the symmetrical axis of the subanal plate at an angle. This is the case also with the angle made by the axis of the madreporic body and the first anal plate of young *Echini*; the position of the axis passing through the anal plate has no definite relation to the madreporic body. The anal opening is covered by small plates, as in other *Echini*.

"The whole abactinal system is studded with embryonic spines, which are longest along the exterior edge of the abactinal system, thus separating it most distinctly from the test. The sutures between the plates are sharply cut with deep pits at the angles of junction of the genital and subanal plate and of the ocular and genital plates. The three larger genital plates have also pits in the middle of their line of junction with the subanal plate. The genital openings are large, placed in the middle of the plates."

A. Agassiz gives slightly magnified views of the specimen from which his description was taken; and the abactinal region is shown with the surrounding spines in one figure, and separate and only connected with an interambulacrum and a whole or a part of an ambulacrum in a second (*op. cit.* pl. iii. figs. 8, 11). These beautiful lithographs show that the form is exceptional amongst the genus *Salenia*; for the anal opening infringes on one generative plate instead of on two, and four generative plates are in contact with a fixed anal plate

which extends on all sides but one around the anal opening. The bulk of the subanal plate is close to and on the side of the madreporic plate; and the almost circular anal opening is eccentric and its position, as A. Agassiz remarks, as in the test of *Hyposalenia* ("The abactinal system has the structure of *Salenia*; but the position of the anal system is that of *Hyposalenia*," *op. cit.* p. 261). *Hyposalenia* = *Peltastes*.

Taking the drawing of A. Agassiz's form (plate iii. figs. 8, 11, Revis. *Echini*) and placing the ocular plate to the left of the madreporic body directly in front, a line drawn through this plate will enter the suture between the madreporic and left front genital plates, and will infringe on the subanal plate; carrying it on, the line will cross the anus leaving the bulk of it to the *left*, and will then cross the posterior genital plate. The anus is very nearly central as regards the antero-posterior axis, and only slightly to the left; but it is behind the anterior half of the apical disk. In this position the two anterior genital plates are the largest, and the two posterior ocular plates are the largest. The subanal plate is of great size, and occludes the right posterior plate as well as the left posterior. The anus is marked with ornamentation, and the plates appear to radiate; only the posterior plate and the subanal limit the anus. The disk is pentagonal and large; and were it that of a fossil form the species would be placed in the genus *Peltastes*; its differences from that of *Salenia profundi* are very evident.

Lovén thus describes the apical system of his *Salenia Goe-siana*:—"The apical system is very large, occupying the greater part of the upper surface; the subanal plate is pentagonal; and the generative plates are very large, hexagonal, with a slightly pronounced seventh angle, corresponding with the reentering angles of the last interradial (interambulacral) plates. The madreporic plate is larger than the others; and the anal orifice is formed by almost equal portions at the expense of the subanal plate and of the posterior and right posterior generative plates. It is oval and has a raised margin. The ocular plates are pentagonal, remote from the anus, and their pore is close to the external edge. All the surface of the apical system is crowded with a great number of tolerably long sessile prominences, which are cylindrical, with a rounded, swollen, reticulate punctate and lobed summit; they are close on the periproct, which is furnished with them. The diameter of the individual is 3.5 millims.; and the madreporic body is visible from within, but not the generative pores."

Lovén's exquisite drawings show the raised anal margin

with its crowd of processes, and the similar bodies on the plates. They are more pronounced than in *Salenia profundæ*, less close, but identical in structure; they are not rudimentary spines. The form is a true *Salenia*; and the ovoid anus is eccentric, posterior, and to the right. The large size of the right and left and posterior plates is remarkable, and, with the difference of the ornamentation and the number of papillæ, distinguishes the species, partly, from *Salenia profundæ*.

In concluding this part of this essay it is necessary to point out the specific characters of *Salenia profundæ*.

*Salenia profundæ*, sp. nov. (Pl. VII. figs. 1-11.)

The test is depressed, the inferior surface being flat and the upper slightly convex. The greater part of the upper surface is occupied by the apical system; the peristomial space is large, and the rest of the test is crowded with tubercles and their spines. There are ten primary tubercles (some very large and some small) in the two vertical rows in each interambulacrum; their spines are of different lengths, some more than four times the diameter of the test, others less, and some very short and conical. The longer spines, often slightly bent, are pin-shaped, with a large milled ring and a constriction beyond. There are two vertical rows of secondary tubercles in the median interambulacral spaces, and one row between the primary tubercles and the poriferous zone. All these have short club-shaped, straight or curved or broad spatula-shaped spines, striated and pigmented.

The ambulacra are narrow, and there are two vertical rows of tubercles closely packed, just within the poriferous zones; and their spines resemble those of the small tubercles of the interambulacra. Other tubercles near the peristome support cylindrical spinulose spines; all are ornamented with pigment granules. The pores are few in number, in simple series, a pair corresponding with each tubercle. Pedicellariæ are amongst the spines, and are short and blunt-headed and bifid.

Sphæridia exist, two close to the peristome and one higher up in each ambulacrum.

The surface of the test is pigmented with dots and granules of dark purple. There are ten buccal plates, the opening for the teeth (actinostome) is small. Teeth triangular and slightly keeled; buccal membrane plain, and only slightly imbricated near the teeth.

Cuts slight; branchiæ bifid or trifid. Pedicellariæ in pairs near the buccal tentacles.

The anus, with a raised margin, is eccentric posteriorly and

to the right, and is formed at the expense of the hexagonal subanal plate and the posterior and right genital plates, which are the smallest. The disk is pentagonal, and the madreporic plate is slightly the largest. Next in size is the plate to the left. The ocular plates are well developed, the three anterior being the largest. The anus has a membrane, and under it plates supporting small spines. All the surface of the apical system is crowded with short, blunt, cylindrical, round-tipped, reticulate, and lobose processes, between which are pedicellariæ; the processes are found on the anal margin, on the anal membrane, and they project from the free surface and edges of the plates.

## EXPLANATION OF PLATE VII.

Fig. 1. *Salenia profundæ*, Dunc.,  $\times \frac{3}{2}$ .

Fig. 2. Anal opening, magnified.

Fig. 3. An ocular plate and part of a generative plate, magnified.

Fig. 4. Club-shaped spines and a pedicellaria, magnified.

Fig. 5. A short serrate spine, magnified.

Fig. 6. A spine at the peristome end of an ambulacrum, magnified.

Fig. 7. A tentacle of a pore, magnified.

Fig. 8. Diagram of the apical disk.

Fig. 9. A pair of buccal tentacles, pedicellariæ, and membrane, magnified.

Fig. 10. A gill.

Fig. 11. A large spine, slightly magnified.

XXXIV.—*Studies on Fossil Sponges*.—I. *Hexactinellida*.

By KARL ALFRED ZITTEL\*.

*Systematic Position of the Hexactinellida*.

Among the numerous discoveries of O. Schmidt in the department of spongology, none has acquired such widely influential importance, from a palæontological point of view, as the establishment and definition of the orders Hexactinellida and Lithistida†. Wyville Thomson‡ had indeed previously indicated the relationship of the Ventriculites of the English Chalk to certain living siliceous sponges; but it was only after Schmidt had shown that the so-called "glass-sponges" (Vi-

\* Translated by W. S. Dallas, F.L.S., from a separate copy of the memoir in the 'Abhandlungen der k. bayer. Akad. der Wiss.' II. Cl. Band xiii. 1877, communicated by the author.

† 'Grundzüge einer Spongienfauna des Atlantischen Gebietes,' Leipzig, 1876.

‡ 'The Depths of the Sea,' Royal Dublin Society, April 1869, and 1873, p. 483.